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M E M O R A N D U M

DATE: July 13, 1999

TO: Metropolitan King County Councilmembers

FROM: Don Eklund, County Auditor

SUBJECT: Special Study – King County Traffic Volume Forecast Model

Attached for your review is the King County Traffic Volume Forecast Model study report. The objective of the review was to determine the reasonableness of the forecasting model in measuring the traffic related impacts of proposed development.

Our general conclusion is that the model used by the Department of Transportation in forecasting traffic volume is reasonable.

- The forecasting model is widely accepted and used in the public and private sectors, and by academic institutions.
- Most of the improvements suggested by the 1996 transportation model study, Inside the Blackbox, were incorporated into the county's forecasting model, and additional improvements are planned.
- Department of Transportation staff have the education and expertise to apply and maintain the forecasting model competently.
- The county's forecasting model is useful for roads capital improvement planning purposes.

We also concluded that the Department of Transportation's internal controls could be strengthened to assure the quality and integrity of the model results. Regardless of the model enhancements and internal control improvements, however, model predictions can only be considered a "best guess" of future traffic volume based on the best available information. According to the Federal Highway Administration, "[e]rror is inherent in all models since they are abstractions of real travel behavior; simplifications of reality are unavoidable in order to make the models usable and practical."

The Executive Response, included in Appendix 2, indicates general agreement with our conclusions and provides timelines for the implementation of study recommendations.

The Auditor's Office appreciates the cooperation received from the Department of Transportation, particularly the Transportation Planning Division's Comprehensive Long-Range Planning Section management and staff.

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SPECIAL STUDY

KING COUNTY TRAFFIC VOLUME FORECAST MODEL

Presented to
the Metropolitan King County Council
by the
County Auditor's Office

Don Eklund, King County Auditor
Bobby Buyco, Senior Management Auditor

Report No. 99-04

TABLE OF CONTENTS

Abbreviations

DOT	King County Department of Transportation
FHWA	Federal Highway Administration
PSRC	Puget Sound Regional Council
TAM	Transportation Adequacy Measure
TSA	Transportation Service Area

REPORT SUMMARY

Introduction

The traffic volume forecast model study was requested by the Metropolitan King County Council and was included in the Auditor's Office 1998 work program.

Background

State and countywide planning policies require transportation services and improvements to be concurrent with new development. Specifically, road improvements must be in place at the time of development, or a financial commitment made to complete improvements within six years of development approval, to maintain the level of service standards established by the county.

The Department of Transportation uses a traffic volume forecast model to measure the increased traffic volume potentially generated by proposed developments. The model forecasts are then compared to the county's established level of service standards. If the forecasted traffic volume increases are consistent with the county's level of service standards—roadway capacity is adequate for the estimated traffic volume increases—the Department of Transportation issues a concurrency certificate to the developer.

Objective

The study objectives were to determine whether: 1) the traffic volume forecast model used by Department of Transportation is widely accepted and used by the public and private sectors; 2) reasonable internal controls are in place to assure to quality and integrity of forecasting model results; 3) relevant improvements were incorporated into the forecasting model; 4) transportation planning staff are qualified to competently apply and maintain the model; and 5) the model provides useful information for roads capital planning purposes.

Conclusion

Despite the inherent weaknesses of predictive models, our conclusion was that the county's traffic volume forecast model volume is reasonable. The model is widely accepted and used in the public and private sectors and by academic institutions, and improvements suggested by the 1996 Inside the Blackbox: Making Transportation Models Work for Livable Communities have been incorporated into the forecasting model. In addition, the Department of Transportation staff have the expertise and education to competently apply and maintain the model, and the model is useful for roads capital improvement planning purposes. However, Department of Transportation's internal controls need to be strengthened to assure the quality and integrity of the forecasts generated by the model.

Scope and Methodology

The study included a review of documents relevant to the traffic forecasting model currently used by the Department of Transportation. However, we did not examine the technical operation of the model due to lack of technical expertise. In addition, we did not test the model's effectiveness or results in predicting the traffic impacts of development (e.g., compare predicted traffic volume to actual traffic volume), because the model reflects 1995 conditions rather than current traffic conditions. While this study reviews the model analysis based on 1995 data, it should be noted that the Department of Transportation, in cooperation with the Puget Sound Regional Council (PSRC), plans to update the forecast model later this year to reflect 1998 conditions.

SUMMARY OF FINDINGS AND RECOMMENDATIONS

FINDING 1 (Page 5)

The County's Traffic Volume Forecast Model is Widely Accepted and Used by State and Local Governments, Academic Institutions, and Private Consulting Agencies.

The county's traffic volume forecast model is actually EMME/2 software. EMME is an acronym derived from "Equilibre Multimodal, Multimodal Equilibrium," which refers to the theory of network equilibrium that underlies the multimodal travel forecast model. EMME/2 is an updated version of EMME software developed in the late 1970s at the University of Montréal.

The EMME/2 forecast model is currently used in 56 countries by over 500 organizations. In the Washington State, current EMME/2 users include the cities of Seattle, Bellevue, and Redmond; Pierce, Snohomish and Kitsap counties; the University of Washington; and several private transportation consulting firms.

FINDING 2 (Page 7)

Internal Control Procedures Could Be Strengthened to Further Assure the Quality and Validity of the Concurrency Test Results.

Internal controls procedures are established to ensure the accuracy and validity of model forecasts. Types of potential modeling errors include measurement, sampling, computational, specification, transfer, and aggregation errors. Internal controls are generally established for data input, data output, and model validation and calibration. Examples of internal control mechanisms include field observations, sensitivity analysis and

expert panel review. One internal control mechanism developed by the Department of Transportation since 1996 was the creation of a review team to evaluate model results. If the review team had been established prior to the concurrency testing for the Blakely Ridge and Northridge developments, an arithmetic error made during the concurrency test would probably have been identified earlier. While the Department of Transportation has established numerous internal controls for its traffic volume forecasting process, we believe that additional enhancements, such as those suggested by the General Accounting Office, would further strengthen the quality of concurrency testing.

We recommend that the Department of Transportation 1) evaluate its internal controls for the concurrency program to incorporate the controls suggested by the General Accounting Office, the Institute of Internal Auditors, and other associations; 2) develop policies and procedures to implement the internal controls developed above; 3) and establish timelines for the implementation of the internal controls. In addition, **we recommend** that the department consider incorporating information regarding the results of the concurrency test and the standards used in the test on the concurrency certificate issued to the developer. Further, **we recommend** that the department consider incorporating sensitivity analysis to its validation and calibration process to identify variables or factors that would have a significant impact on the model output.

FINDING 3 (Page 16)

The Department of Transportation and the Puget Sound Regional Council Incorporated 9 of 15 (60%) of the Relevant Improvements Suggested by a 1996 Transportation Model Study, and Planned to Incorporate the Remaining Improvements (40%).

In 1996, a study titled Inside the Blackbox: Making Transportation Models Work for Livable Communities offered numerous suggestions to correct some common biases and problems that could affect model forecasts. Fifteen (15) of the study suggestions were relevant to the county's forecasting model. The Department of Transportation indicated that 9 of the 15 (60%) relevant suggestions have been incorporated into the county's model. The 6 remaining suggestions (40%) will be incorporated into the county's model when it is updated to reflect 1998 conditions.

We recommend that Department of Transportation continue its efforts to update and improve the quality and integrity of data used in the traffic volume forecast model.

FINDING 4 (Page 18)

The Department of Transportation Staff Were Qualified to Apply and Maintain the Forecasting Model.

Department of Transportation staff possess the experience and education necessary to apply and maintain the forecasting model competently. The 10 staff members who are responsible for the county's forecasting model collectively possess 181 years of experience in transportation engineering; 17 PhD, master's and bachelor's degrees; and 2 professional engineering licenses.

FINDING 5 (Page 19) **The County's Traffic Volume Forecast Model Was Useful for Roads Capital Improvement Planning Purposes.**

According to the Department of Transportation, the traffic volume forecast model plays an important role in the development of the annual roads capital improvement program. The Growth Management Act requires a direct linkage between land use and transportation services, and the forecast model is the strategic tool that links land use and transportation planning with the implementation of roads capital improvement program.

AUDITOR'S MANDATE

The Traffic Volume Forecast Model used by the Department of Transportation was reviewed by the County Auditor's Office pursuant to Section 250 of the King County Home Rule Charter and Chapter 2.20 of the King County Code.

1 INTRODUCTION

The traffic volume forecast model study was requested by the Metropolitan King County Council and was included in the Auditor's Office 1998 work program.

Background

The Washington State Growth Management Act[1] and the King County Comprehensive Plan[2] require transportation services to be consistent with urban and rural land uses and balance transportation needs with improvements and financing. State and countywide planning policies also require transportation services and improvements to be concurrent with new development. This means that transportation improvements or strategies must be in place at the time of development, or a financial commitment made to implement improvements or strategies within six years of development approval, to maintain the level of service standards established by the county.

The Department of Transportation uses a traffic volume forecast model to estimate traffic impacts and to test proposed developments for concurrency. Traffic impacts for proposed developments are measured by the increased volume of vehicles on each roadway that are directly attributable to the proposed development. The ability of a roadway to carry traffic is described as its capacity, which is expressed as the number of vehicles per hour that the roadway can carry. The level of service is expressed as the ratio of volume-to-capacity. If traffic impacts are found to be within the county's established level of service standards, the department issues a concurrency

[1] Revised Code of Washington 36.70A and 36.70A.070.
[2] King County Code 14.65 and 14.70.

certificate to the developer. The concurrency certificate is required to obtain a development permit from the Department of Development and Environmental Services.

The concurrency test consists of two parts: 1) the Transportation Adequacy Measure (TAM) score and 2) the critical links analysis. Both parts of the test must be passed to qualify for a concurrency certificate.

1) The TAM score is a calculation of the weighted average volume/capacity ratio of roadway links that serve traffic to and from a transportation zone or proposed development. The volume/capacity ratio includes existing, background[3] and projected traffic on the road network. The resulting TAM score is compared to the maximum allowable average volume/capacity zonal score in the applicable Transportation Service Area (TSA). The standards vary by service area. The Northridge and Blakely Ridge planned developments, for example, are in "TSA 3" with a maximum allowable average volume/capacity value of 0.89.

2) The critical links test measures the volume/capacity ratio for individual links on key roadways that have been designated as essential to county mobility. If the volume/capacity ratio exceeds 1.1, meaning that the projected traffic volume during the afternoon peak hour is 110% of road capacity, and if the development sends 30% or more of its trips to that link, the development will not pass the critical links test. The developer is then denied a concurrency certificate.

Objective

The study objectives were to determine whether: 1) the traffic volume forecast model used by Department of Transportation is

[3] "Background traffic" is traffic associated with other proposed developments that have been approved for concurrency, but that have not yet been built.

widely accepted and used by the public and private sectors; 2) appropriate internal controls are in place to assure to quality and integrity of forecasting model results; 3) relevant improvements were incorporated into the forecasting model; 4) Department of Transportation staff are qualified to competently apply and maintain the model; and 5) the model provides useful information for roads capital planning purposes.

Scope

The study included a review of documents relevant to the traffic forecasting model currently used by the Department of Transportation. However, we did not examine the technical operation of the model due to lack of technical expertise. In addition, we did not test the model's effectiveness or results in predicting the traffic impacts of development (e.g., compare predicted traffic volume to actual traffic volume), because the model reflects 1995 conditions rather than current traffic conditions. While this study reviews the model analysis based on 1995 data, it should be noted that the Department of Transportation, in cooperation with the Puget Sound Regional Council (PSRC), plans to update the forecast model later this year to reflect 1998 conditions.

Methodology

To determine whether the Department of Transportation traffic volume forecast model meets the audit objectives, audit staff used the following criteria:

- State and local governments, academic institutions, and private consulting agencies generally accept the model.
- Internal controls and/or checks are established to reasonably ensure the quality and validity of its analysis results (i.e., use various scenarios when running the model in order to test its sensitivity given different data input, peer review, field observation, etc).
- The model incorporates or has incorporated relevant and

appropriate improvements suggested by the 1996 transportation model study, Inside the Blackbox: Making Transportation Models Work for Livable Communities.[4]

- Staff responsible for traffic forecasting are qualified and competent individuals based upon academic credentials and experience.
- The model output provides useful information for roads capital improvement planning purposes.

Audit staff then determined whether each criterion was present or was met. Our work consisted of a review of available documents and interviews with Department of Transportation personnel and other individuals with relevant and significant information.

[4] Edward Beimborn, Professor (School of Engineering, University of Wisconsin-Milwaukee), Rob Kennedy, Ph.D., and William Schaefer, Inside the Blackbox: Making Transportation Models Work for Livable Communities, Citizen for a Better Environment and the Environment Defense Fund, Joyce Foundation, Milwaukee, WI, 1996. Edward Beimborn, Professor (School of Engineering, University of Wisconsin-Milwaukee), Rob Kennedy, Ph.D., and William Schaefer, Inside the Blackbox: Making Transportation Models Work for Livable Communities, Citizen for a Better Environment and the Environment Defense Fund, Joyce Foundation, Milwaukee, WI, 1996.

2 FINDINGS AND RECOMMENDATIONS

Introduction

Traffic forecast modeling incorporates many variables and approaches that are not within the scope of this study, such as the technical aspects and operation of models. The following findings describe five specific evaluation criteria which were considered to be important elements of a traffic model to ensure acceptable and consistent results. Our analysis focused on a comparison of conditions and performance to the five criteria.

FINDING 1

THE COUNTY'S TRAFFIC VOLUME FORECAST MODEL IS WIDELY ACCEPTED AND USED BY STATE AND LOCAL GOVERNMENTS, ACADEMIC INSTITUTIONS, AND PRIVATE CONSULTING AGENCIES.

Criterion for Evaluation

Transportation models are important because they predict future traffic volumes. Information generated from traffic models is used for planning transit routes, roads, and residential and commercial development. One factor that lends credibility to forecasting models is the extent to which the models are used by other jurisdictions and educational institutions. Consequently, an effort was made to determine whether the EMME/2 model was generally accepted and used by other transportation planning organizations.

EMME/2 Model

The Department of Transportation uses the EMME/2 software to forecast and evaluate traffic impacts created by proposed developments. The EMME/2 acronym is derived from "Equilibre Multimodal, Multimodal Equilibrium" which refers in French and English to the theory of network equilibrium which underlies the

multimodal travel forecasting model. The "2" designation refers to the second generation of original EMME software that was developed in the late 1970s at the University of Montréal's Center for Research on Transportation. The first version of EMME/2 was also developed at the Center for Research in the early 1980's, and then further enhanced by INRO Consultants, Inc., of Montréal in 1986.

According to INRO Consultants, Inc., EMME/2 is currently used by more than 500 organizations in 56 countries. EMME/2 users include cities, metropolitan authorities, transit agencies, consulting firms, and universities. In the state of Washington users include the cities of Bellevue, Federal Way, Redmond, Renton, and Seattle; King, Kitsap, Pierce, and Snohomish counties, and the University of Washington, as well several private transportation consulting firms.[5] In addition, EMME/2 is used in Europe, Asia, Central and South America, Africa and Australia.

Auditor's Conclusion

Based upon the broad range of national and international users, our conclusion is that EMME/2 is widely accepted in the public and private sectors, as well as in the academia.

RECOMMENDATION

None.

Executive Response

"My staff and I concur with the conclusion stated in Finding 2 that the EMME/2 travel model is an appropriate tool and is recognized as such by Washington State and local governments, academic institutions, and private consulting agencies--both nationally and internationally."

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[5] Source: EMME/2 NEWS Number 17 - May 1995

FINDING 2

INTERNAL CONTROL PROCEDURES COULD BE STRENGTHENED TO FURTHER ASSURE THE QUALITY AND VALIDITY OF THE CONCURRENCY TEST RESULTS.

Criterion for Evaluation

A second factor that lends credibility to a traffic forecasting model is the extent or range of internal controls that are established to ensure the accuracy and validity of forecasting results. This finding focuses on the reasonableness of the Department of Transportation's internal controls and other measures to ensure quality and validity of the concurrency test results.

The primary purpose of internal controls is to minimize the risk of errors and irregularities. Types of potential modeling errors include measurement, sampling, computational, specification, transfer, and aggregation errors. Several General Accounting Office publications deal with the issue of internal controls and assessment of computer based systems.[6] These publications discuss control techniques and procedures which could be employed in three areas: data input controls, output controls, and model validation and calibration.

DATA INPUT CONTROLS

Data input controls are designed to ensure that data is entered into the application in an accurate, complete, and timely manner. King County's transportation concurrency model calculates trip generation based on land use data. However, in the case of Blakely Ridge and Northridge projects, the department and developers agreed to use data developed by a consultant. The data was considered to be more accurate, because it was based on current conditions. The consultant data used in the concurrency test was also consistent with the

[6] Assessing the Reliability of Computer-Processes Data, April 1991; Assessing Internal Controls in Performance Audits, September 1990; Evaluating Internal Controls in Computer-Based Systems, June 1981, United States General Accounting Office.

data used in Draft Environmental Impact Statement for the proposed development. The use of consultant data required the direct input of trip generation data into the concurrency model.

Calculation Error

The initial test results were questioned by a citizen, and department staff determined that an error had been made in the original concurrency test runs. The error involved the unintentional subtraction of internal trips from net trips rather than from gross trips. That is, the number of internal trips (25) were subtracted from the net (75) rather than the gross trips (100). The error resulted in double counting the internal trips (50), and underestimating traffic volume. The King County Executive ordered a re-test using the correct data, and the Blakely Ridge and Northridge developments were able to pass both parts of the concurrency test based on the corrected data.

Conditional Concurrency Certificate

In addition, the certificate of concurrency issued for Blakely Ridge and Northridge projects included conditions in the development agreement that were stronger than the requirements set forth in the county's concurrency ordinance. According to the department, these conditions ensured that the planned developments could proceed only if "actual measured traffic volumes" remained at an acceptable level. This approach provided the ultimate safeguard for the public, because traffic impacts could be minimized if actual traffic volumes grew at a faster rate than was forecasted.

Review Team Established

Subsequent to the Blakely Ridge and Northridge projects, the department initiated a review team process to assess the initial output of the concurrency test. The team, comprised of technical staff, principal planners and a supervisory planner, reviews such items as proposed project location, trip generation rate, trip distribution, volume to capacity ratios, link speed, and

length. In addition, the team evaluates the reasonableness of the test results and may suggest additional runs incorporating other important variables. The department believes that the current review team would probably have detected the error that occurred in the Blakely Ridge and Northridge concurrency tests.

Planned Development Changes in Size and Scope

Since the concurrency tests were run, changes in the scope and road layout of the Blakely Ridge development were considered. The scope of the development was reduced and informational concurrency tests were performed to incorporate an alternate road layout. The test, which increased the traffic volume, resulted in a higher TAM score, and the critical links test still showed less than 30% of the trips going to that link or roadway. In order to pass the concurrency test, both the volume/capacity ratio and critical link tests must exceed established county standards. According to DOT, the Blakely Ridge development continued to pass the concurrency test.

Auditor's Conclusion

Notwithstanding the conditions imposed by the county on the issuance of the concurrency certificate for Blakely Ridge and Northridge, the fact remains that erroneous data were used in the concurrency test. This error could have been discovered if adequate internal controls had been in place, such as the review team that was subsequently established by the department. Internal control improvements might also be developed that address the following questions:

- Are there documented procedures for entering data into the application?
- Is data validation and editing performed on all data fields before entry into the system?
- Is there a control group accountable for data input and output quality and validity?

The establishment of internal controls is management's responsibility, but internal controls should be designed with input from the operating units and designed with cost-benefit in mind.

DATA OUTPUT CONTROLS

Data output controls are used to insure the integrity of system output and the correct and timely distribution of output. A form of data output control is a review of output by an independent person or team.

"The Black Box"

Transportation models have often been viewed by government officials and the public as a "black box." Numbers, maps, statistics and other information go into the box and travel forecasts come out which become the basis for decisions. The results of these analyses, partly because of their complexity and technical nature, are often not fully explained to decision makers.

Hearing Examiner

The concurrency test results in approval or rejection of the proposed development. The test results are included in the proposed project environmental impact assessment, subject to review by the Hearing Examiner.

Auditor's Conclusion

The review of the initial output of the concurrency test by the technical review team (discussed above) provides a check of data input, process, and test results. According to the department, the concurrency certificate is issued under the signature and approval of the section manager. Review by the Hearing Examiner provides an additional impartial review of test results.

MODEL VALIDATION AND CALIBRATION

Validation involves the testing of the model's predictive capabilities. The model predictions are compared to observed data. For example, predicted traffic volume is compared to actual traffic counts. Model calibration involves adjusting the

model after a comparison of model outputs to observed data until the model results fall within an acceptable range of error. This adjustment process and the acceptability of results are based upon established guidelines and professional judgement.

The Department of Transportation has validated and calibrated the model for the 1993 base year condition and revised the original 1995 base year traffic model to a new 1995 base year, due to the Hearing Examiner's initial findings in its review of the proposed development called Greens at Beaver Crest. The Hearing Examiner found that the model used by the department for determination of concurrency was unreliable due in part to inadequate data and improper modeling techniques. However, aspects of the Hearing Examiner's findings are being appealed by the department.

Methodology Guided by Federal Highway Administration Publications

According to county management and staff, the U.S. Department of Transportation, Federal Highway Administration publications, titled Calibration and Adjustment of System Planning Models[7] and Model Validation and Reasonableness Checking Manual[8] were used to guide model validation and calibration. The Federal Highway Administration publications also included performance measures for evaluating the model's results. Comparison of the county's model output to these performance measures indicates that the output is within standards. The Federal Highway Administration's performance standards and the county's model results are shown in Exhibit A.

[7] Calibration and Adjustment of System Planning Models, U.S. Department of Transportation, Federal Highway Administration, Publication No. FHWA-ED-90-015, December 1990.
[8] Model Validation and Reasonableness Checking Manual, Travel Model Improvement Program, Federal Highway Administration, Barton-Aschman Associates, Inc. and Cambridge Systematics, Inc., February 1997, p. 10.

EXHIBIT A

Comparison of the Federal Highway Administration Reasonableness Standards to the Department of Transportation Model Results

Reasonableness Checks	FHWA* (Daily Model)	KC Retest Model ** (PM Peak)
Percent Error by Region-wide (Based on Observed Counts)	Less Than 5%	1%
Percent Error by Functional Classification		
Freeways	Less Than 7%	5%
Principal Arterials	Less Than 10%	6%
Minor Arterials	Less Than 15%	3%
Collectors	Less Than 25%	14%
Correlation Coefficient (Based on Observed Counts)	More Than 0.88	(Two Way) 0.95 (One Way) 0.93
Vehicle Miles Traveled by Functional Classification		
Freeway/Expressway	40%	39%
Other Principal Arterials	27%	27%
Minor Arterials	18-22%	15%
Collectors	8-12%	5%
Vehicle Miles Traveled Per Person	17-24 miles	17 miles
Vehicle Miles Traveled Per Household	40-60 miles	37 miles

*Source: FHWA, Calibration and Adjustment of System Planning Models, 1990
**Source: The Department of Transportation (Unaudited)

Department of Transportation Model Results Consistent With Federal Highway Administration Reasonableness Standards

As shown in Exhibit A, the Department of Transportation's model results not only met but generally exceeded the Federal Highway Administration standards. The following is an explanation of Exhibit A:

- The Percent Error Region Wide is the total assigned traffic volume divided by the total counted traffic volumes (ground counts) for all the links that have counted volume. The Federal Highway Administration recommends that ground counts be greater than 65% of the freeway and principal arterial network links. Ideally, ground counts should be 100%, but this is not realistically possible. The county's ground counts represents 59% of 220 locations. Counts for the other locations were adjusted by using 1999 "Annual

Traffic Projection" factor tables published by Traffic Engineering, Road Services Division.

- The Percent Error by Functional Classification is the total assigned traffic volume divided by the total counted traffic volume for all links that have counted volume by functional classification. This provides insight into whether the assignment model is loading trips by classification in a reasonable manner.
- The Correlation Coefficient (r) compares how much the model-predicted traffic volume and the actual traffic count are related. The Federal Highway Administration suggests that the correlation coefficient should be greater than 0.88 for daily, two way traffic projections. The correlation coefficient always has a value between –1 and +1. A value of 1.00 indicates that all data points fall on a straight line or that the predicted traffic volume is equal to the actual traffic count.
- Annual performance measures based on Vehicle Miles Traveled provide a good check on the reasonableness of the assigned base year traffic. If the comparison of assigned to counted vehicle miles traveled is not satisfactory, the most probable cause is an error in the trip length frequency distribution. The Federal Highway Administration suggests that the assigned vehicles miles traveled should be within 5% of the estimated vehicles miles traveled.

The Federal Highway Administration manual provided guidelines for the calibration and adjustment of system planning models. Our limited review of documents provided by the department indicates (with the exception of the performance of sensitivity analysis) compliance with the suggested methodology. A summary of the 1995 updates is included in Appendix 1.

Sensitivity Analysis or Tests Not Done

Sensitivity analysis is suggested by the aforementioned publications to test model sensitivity to changes in the variables included or not included in the model, or the elasticity of a variable. The Beimborn, et. al., study suggests that model coefficients may be borrowed from other regions to improve or test model sensitivity or to adjust model outputs for other factors. According to DOT, the model used locally developed coefficients that have been found to be effective. The study further suggests that sensitivity analysis be used to answer specific questions not adequately covered by a model or expert panel.[9]

The Federal Highway Administration publication suggests sensitivity tests as a validation check.[10] These include tests of model responses to changes in transportation systems, socioeconomic conditions, or policy. For example, we might examine the impact on traffic volume if parking costs were doubled, if tolls were charged on bridges, or if bus service was expanded. Sensitivity analysis is important because policies and conditions may surface that did not exist in the base year. However, the department has not performed a sensitivity analysis for its model, and depends on regional tests performed by the PSRC.

Consultant Evaluated Transportation Adequacy Measures

In 1994, Rao Associates, Inc., a consultant retained by the county, evaluated the county's Transportation Adequacy Measure (TAM) in three areas. These areas included transportation planning, traffic modeling, and level of service (LOS) strategies and policies. The consultant issued a report that included 15 concerns and recommendations. Although we did not confirm implementation of these recommendations, the

[9] Edward Beimborn, Rob Kennedy, and William Schaefer, pp. 27 and 40.
[10] Model Validation and Reasonableness Checking Manual, pp. 6-7.

response we received from the Department of Transportation indicated that the recommendations were addressed.

Auditor's Conclusion

A validated and calibrated model should reasonably be able to predict future traffic volumes. However according to the Federal Highway Administration publication, "[e]rror is inherent in all models since they are abstractions of real travel behavior; simplifications of reality are unavoidable in order to make the models usable and practical."[11] The model depends on input of information whose quality and accuracy may also be in question. Sources of error include measurement, sampling, computational, specification, transfer, and aggregation errors. The Federal Highway Administration warns that, "[w]hen comparing forecasted volumes to ground counts, it is important to recognize that the ground counts probably contain a significant amount of error."[12] In addition, unanticipated future events, which could affect any of the variables included in the model, may significantly impact the model predicted traffic volume. Thus, the traffic volume predicted by the model should be considered as a "best guess" of future traffic volume based on the best available information.

RECOMMENDATIONS

2-1 The Department of Transportation should:

- Evaluate the internal controls being employed in the concurrency program to make sure that it incorporates controls such as those suggested by the General Accounting Office, the Institute of Internal Auditors, and other associations.
- Develop policies and procedures to implement the internal controls developed above.

[11] Ibid., p. 10.
[12] Calibration and Adjustment of System Planning Models, p. 33.

- Establish timelines for the implementation of the internal controls.

Executive Response *"This recommendation is being implemented and will be complete by September 1, 1999."*

2-2 The Department of Transportation should consider incorporating information regarding the results of the concurrency test and the standards used in the test on the concurrency certificate issued to the developer.

Executive Response *"Information regarding the concurrency test failure is routinely sent to the developer. All files are open for public inspection. A summary sheet that includes the Transportation Adequacy Measure (TAM) standard and TAM score will be added as an enclosure to the concurrency certificate."*

2-3 The Department of Transportation should consider incorporating sensitivity analysis to its validation and calibration process to identify variables or factors that would have a significant impact on the model output.

Executive Response *"Sensitivity analysis is a separate process from the calibration and validation process. The Puget Sound Regional Council (PSRC) currently performs sensitivity analysis on the "parent" model of King County's model. This is the appropriate application of sensitivity analysis. DOT staff will participate as members of the technical team with PSRC staff as they perform sensitivity testing on the regional model."*

FINDING 3 **THE DEPARTMENT OF TRANSPORTATION AND THE PUGET SOUND REGIONAL COUNCIL INCORPORATED 9 OF 15 (60%) RELEVANT IMPROVEMENTS SUGGESTED BY A 1996 TRANSPORTATION MODEL STUDY, AND PLANNED TO INCORPORATE THE REMAINING IMPROVEMENTS (40%).**

Criterion for Evaluation

The Department of Transportation traffic model has incorporated most of the relevant and appropriate improvements suggested by a 1996 transportation model study titled "Inside the Blackbox: Making Transportation Models Work for Livable Communities."[13] In addition to providing a basic understanding of the transportation modeling process, the Blackbox study makes a number of suggestions to correct some of the typical biases and other problems that could affect the forecasted output. The suggestions are generally technical in nature and directed toward transportation planning personnel.

All of the Relevant Study Suggestions are Being Incorporated or In-progress

The Department of Transportation response to our inquiry regarding the implementation of suggestions described in the study indicated that 9 out of 15 (60%) suggestions have been incorporated into the model. Six (6) of the 15 (40%) suggestions are in the process of being incorporated into the model. Eight (8) other suggestions made in the study were not applicable to the model being used by the county. Some suggestions are being implemented by the Puget Sound Regional Council, which is the agency responsible for regional land use forecasting and standards. Any improvement of the county's model should be consistent with PSRC's regional model.

Auditor's Conclusion

The department's response to our inquiry also states that there is an ongoing work program to improve and update the traffic volume forecast model that is scheduled for implementation in late 1999. It appears that the department is moving in the right direction by encouraging improvements in the quality and integrity of the input data.

[13] Edward Beimborn, Rob Kennedy, and William Schaefer.

RECOMMENDATION

3-1 The Department of Transportation should continue its efforts to update and improve the quality and integrity of data used in the model.

Executive Response *"I concur with the conclusion stated in Finding 3 that relevant and appropriate improvements suggested by the 1996 Blackbox study have been or will be incorporated into the County modeling process. I also concur with the associated recommendation to continue to update the quality and integrity of the data used in the model. This recommendation is standard practice in DOT, where staff are in the process of a major model update with the technical involvement and advice from PSRC."*

FINDING 4 **DEPARTMENT OF TRANSPORTATION STAFF WERE QUALIFIED TO APPLY AND MAINTAIN THE FORECASTING MODEL.**

Criterion for Evaluation The Department of Transportation staff involved in traffic forecasting are highly qualified and competent individuals based upon experience and academic credentials.

Audit staff summarized the experience, academic credentials, and professional licenses for Department of Transportation staff involved in traffic forecasting. We found that the 10 staff members, who are responsible for modeling or traffic forecasting, are highly experienced with a broad range of education, training, and background. The staff collectively has 181 years of experience in the area of transportation engineering; 10 bachelor's degrees, 6 master's degrees, and 1 doctorate degree; and 2 Professional Engineer licenses. Most of their degrees are in relevant areas. Numerous staff have also attended seminars, conferences, and/or workshops on travel demand forecasting, modeling, and transportation planning.

Auditor's Conclusion Transportation planning staff are highly qualified in terms of education and experience to competently perform their duties. In addition, county staff sought information or assistance from outside consultants and other governmental or quasi-governmental agencies, as required.

RECOMMENDATION None.

Executive Response *"I concur with the conclusion in Finding 4 that DOT staff are highly qualified and competent. I am personally very proud of the technical staff we have developed over the years and the strides the County has taken to become a leader in regional, technical activities."*

FINDING 5 **THE COUNTY'S FORECASTING WAS USEFUL FOR ROADS CAPITAL IMPROVEMENT PLANNING PURPOSES.**

Criterion for Evaluation This criterion considers the utility of the model in providing useful and appropriate information for capital improvement program planning.

The Department of Transportation's response to audit inquiries regarding the use of the traffic model for roads capital planning indicated that the travel forecast model plays a significant role. According to department staff, model results are used to represent "snapshots" in future time to estimate travel demand. The model and its output are used specifically in the following programs related to capital improvement planning:

- Transportation Needs Report -- the listing of current and future transportation needs to implement the Comprehensive Plan. Model forecasts are used to identify needs and to prioritize projects for implementation. This is a

key input in developing the annual capital improvement program.

- Mitigation Payment System -- the transportation impact fee system for new developments. The model is used to test and calculate impacts and establish fees. The fees are collected and applied to projects identified in the Transportation Needs Report.
- Transportation Concurrency Management -- new development requirement from the Growth Management Act to match growth with the availability of adequate facilities. Forecasts are used to test, analyze, and determine whether new developments pass transportation level-of-service standards and meet concurrency. If successful, applicants are issued a Concurrency Certificate as a prerequisite for filing a development permit application. Concurrency needs, matching growth and facilities, play a significant role in developing the annual capital improvement program.

- Capital Improvement Project Level Environmental Impact Statements --analysis and environmental work to support alternatives and design work for capital projects. Forecasts are used to analyze alternatives and impacts of CIP projects as part of the environmental review process.

Auditor's Conclusion

The Growth Management Act requires a direct linkage between land use and transportation. The model provides this connection and is a strategic tool in linking land use and transportation planning with the implementation function occurring in the CIP. Use of the forecast model in other applications, such as in the capital improvement planning process, amplifies the importance of instituting appropriate internal controls to ensure data integrity. The potential cost impact of a mistake in capital planning cannot be overemphasized.

RECOMMENDATION

5-1 See Recommendation 3-1.

Executive Response

"I concur with the conclusion in Finding 5 and have implemented internal controls to ensure data integrity. Staff will continue to review processes in an effort to identify and implement further controls. DOT staff acknowledge the importance of modeling activities in the development of the Transportation Needs Report, Mitigation Payment System, Transportation Concurrency, and Capital Improvement Program development."

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APPENDICES

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APPENDIX 1

BASE YEAR TRAFFIC MODEL R95

KING COUNTY DEPARTMENT OF TRANSPORTATION

DESCRIPTION OF BASE YEAR TRAFFIC MODEL R95,
and resolutions of the modeling issues raised in the Greens report.

January 1999

INTRODUCTION

The King County Department of Transportation (KCDOT) has testified in a 1998 land use appeals hearing concerning its traffic model structure and data (Greens at Beaver Crest and Bordeaux). The Hearing Examiner's report on that hearing, issued on October 23, 1998, made a number of findings regarding the traffic model and the way in which KCDOT determined the traffic concurrency of the proposed development project. The findings are currently under appeal to the Hearing Examiner for reconsideration and reopening of the hearing on several points.

The report concluded that the KCDOT traffic model was unreliable in its determination of concurrency, due in part to inadequate data, and in part to improper modeling techniques. While certain findings of the report are being contested, it is clear that many of the Hearing Examiner's findings in the Greens case must be redressed if the KCDOT traffic model is to be considered to be reliable and acceptable in future proceedings. In particular, two such proceedings will allow the introduction of testimony on the retesting of projects for concurrency, Cedar Cove and Greens/Bordeaux.

The KCDOT has revised its original 1995 base year traffic model to a new 1995 base year according to the Hearing Examiner's findings in the Greens case. The work to revise it and the results of that work are reported here, together with printed examples of maps and tables that support the new model and that document the model inputs and results. The details of the work described here are related to the Hearing Examiner's report so that the reader may understand both the Examiner's critical comments and the KCDOT's technical responses.

This report describes the data inputs and sources, and the modeling results achieved by the KCDOT in developing R95, its new base year traffic model. If the reader wishes for background on model structure and process, he is referred to Exhibit #152 in the Greens hearing. The actual data banks, macros, and trip generation spreadsheet are contained on the R95 CD-ROM available from the KCDOT.

This report is not a full technical documentation of R95. The time constraints on the modeling and hearing processes prevent such a document from being prepared at this time. It is expected that such documentation will be prepared during 1999.

SUMMARY OF R95 UPDATE TASKS

The following points are the major tasks performed by the KCDOT staff to build a 1995 base year traffic model, to be used for retesting development projects for concurrency as part of the appeals process. and also to test new concurrency applications.

Land Use
The R95 traffic model uses 1995 population and employment data for King County, arranged by traffic analysis zone (TAZ). The data was placed into KCDOT zones by area allocation from the Assessor's quarter sections (population) and from the PSRC zones (employment). The zonal housing allocations were adjusted for sensitive areas and buildable lands.

Traffic Counts
KCDOT has assembled p. m. peak hour traffic counts for about 220 locations on the highway and arterial systems. Of these, 59 % were actual 1995 counts, the others were factored from the nearest available information. Counts were secured from King County, cities in King County, and the WSDOT. The count data is used to provide accurate information for the screenline analysis of the R95 model results. In addition to the screenline counts, 344 one way counts were used in the link analysis of model output.

Capacity
KCDOT has re-evaluated the road links in the traffic model and has determined that there are only two roadways on the East Sammamish Plateau that qualify as "long Distance" links, part of East Lake Sammamish Parkway and SE 43 St. The capacities of those links has been determined by intersection analysis, and designating a VDF value to those links that results in the capacity of the intersections.

All the other links on the Plateau are categorized as "short distance" links. Their appropriate VDF values have been determined by field checking the roads and intersections.

Screen Line Analysis
KCDOT has established 23 screenlines within the county, and has compared the R95 traffic results at each of those screenlines with the traffic count data assembled for 1995. The results show that, overall, R95 models 98.6% of the counted traffic volumes at the screenlines, well within national standards.

VMT Comparisons
These comparisons show that, of the total 4.654 million VMT, 38.8% are on freeways (40% standard) and 27.2% are on principal arterials (27% standard).

Comparison to National Standards
KCDOT has used the publication Calibration and Adjustment of System Planning Models, December 1990, U. S. Department of Transportation, as its source of traffic modeling standards. The standards are for a daily traffic model, however the KCDOT R95 peak hour model meets those standards.

R95 MODEL DESCRIPTION

The following table is a description of the several traffic modeling issues raised by Hearing Examiner Stafford Smith in his report of October 23, 1998 regarding the Greens at Beaver Crest and Bordeaux,

and the KCDOT responses to those issues in its revised base year traffic model R95. By addressing these issues positively, the Department expects to be able to respond to the findings on its old traffic model by making corrections and improvements in its new model. Such action will result in reliable concurrency determinations for various projects.

The Department has used 1995 data to develop the revised model, and to calibrate and validate its results. The complete data banks and macros are contained on a CD-ROM disk available from the KCDOT.

The application of R95 for the redetermination of concurrency for specific projects will be documented separately. That separate description will explain the use of R95 as performed for the project.

TABLE OF TRAFFIC MODEL ISSUES AND THEIR RESOLUTIONS IN THE R95 TRAFFIC MODEL.

GREENS REPORT Page/ Item #	ITEMIZED SUMMARY OF ISSUES RAISED BY HEARING EXAMINER	KCDOT RESPONSE IN R95 TRAFFIC MODEL TO EACH ISSUE	ATTACH. #
15/40	KCDOT was correct to use the PSRC trip generation factors.	R95 uses the PSRC trip generation equations documented by KJSA. The equations are applied to the 1995 land use data directly. The 1995 population data came from the 1995 King County Assessor's Office. The 1995 employment data came from the State Department of Employment Security, as separated into traffic zones by PSRC. The trip generation equations are attached; the full trip generation spreadsheet is included on the CD-ROM. Also attached is a printout of the spreadsheet for the Plateau zones.	1540
16/42	The traffic model was poorly calibrated, possibly as a result of the 1993 data used.	The R95 traffic model is calibrated according to the standards described in the USDOT report entitled Calibration and adjustment of System Planning Models. Of the screenline traffic counts, 59% are 1995 counts. A description of the 1995 Assessor's data for population is attached.	1642
17/44	The calibration errors exceed national standards.	R95 is a peak hour traffic model, for which there are no readily available standards. KCDOT has checked the R95 model results against the counted traffic volumes on 788 one-way links. The results of the comparison is shown on the attachment. For the one-way links, the regression coefficient is 0.87; for the two-way roads, it is 0.90. This compares to a national standard of 0.88 for daily two-way roads.	1744
17/47	The KCDOT does not use an acceptable calibration standard.	The R95 model calibration is done according to the USDOT publication cited above. Attached are the comparisons of R95 VMT to the national standards.	1747
18/49	KCDOT overestimated road capacities because committed CIP road projects were later delayed or abandoned	This issue will be discussed for specific project concurrency determinations. The base year model only includes roads that are open for traffic in 1995.	

APPENDIX 1 (Continued)

18/50	Audit report findings on delays of CIP projects and funding concerns.	The KCDOT is required to use the road projects in the current CIP that are fully funded for construction (KCC 14.70.100). It is impossible to determine the fate of a committed project at the time the CIP is approved.	
18/51	CIP deferral problems resulted in overstatement of capacities and lowered TAM scores.	The project completion dates used by KCDOT have been those approved by Council in its CIP approval. The 228 Ave. improvement project was fully funded both before and after 1995; its reduced status in the 1995 CIP was only an interim measure until the Council restored full funding in 1996.	
18/52	Effect on link capacity of the use of a one mile or a two mile distance criteria between controlled intersections.	Only East Lake Sam. Pkwy and SE43 St. south of Pine Lake are categorized as long distance in the coded network. Their capacities have been determined by the VDF categories which most nearly match the capacities calculated by intersection analysis. The attached map shows the "long Distance" links and also the intersections where capacity analysis has been performed in order to determine link capacities.	**1852**
19/53	Classification of 228 NE/SE links as short or long distances between controlled intersections.	All links on 228Ave. SE/NE are classified as short distance north of Pine Lake.	
19/54	Lack of KCDOT documentation for use of one mile criteria for long distance and use of old VDF table.	KCDOT has documentation which justifies its use of a one mile distance between controlled intersections as a long distance. That documentation is attached.	**1954**
19/55	The long distance criterion is not warranted on the Plateau because its roads are not rural. There are no local studies to warrant the use of a one mile spacing. Road capacities should be based in part on traffic signals to be installed within six years	See above response. Signals expected to be installed in the next six years are taken into account in the determination of short distance links.	
20/56	Use of two way level of service on 38 links increases capacities.	See below.	
20/57	The use of two way level of service on the Plateau overstates road capacities.	The R95 model does not use two way level of service on any link in the model.	
20/58	The Department adjusted the v/c ratios of certain links, reducing them if they exceeded 1.1.	The R95 model does not adjust any v/c ratios.	
20/59	KCDOT explanation of v/c adjustment process and its rationale.	See above.	
21/60	V/c adjustment practice does not reflect driver behavior.	See above.	
21/61	Model should represent traffic demand. V/c ratios should not be reduced.	See above.	

APPENDIX 1 (Continued)

21/62	The four listed model adjustments are technical errors and produce artificially low TAM scores.	Of the fours items noted by the Examiner, the CIP projects are required by Code to be included in the committed network, the short/long distance issue is documented for the two long distance roads, two way level of service has been eliminated, and no v/c ratios have been adjusted in R95.	
22/65	Previous model update work has not accounted for growth in cities of population and employment.	R95 contains actual 1995 land use data. The population figures are taken from the County Assessor's office. The employment data is taken from the PSRC information derived in turn from the State Employment Security office. The land use data is listed by zone in the trip generation spreadsheet on the R95 CD-ROM. A portion of the trip generation spreadsheet for the Plateau zones is attached. The full spreadsheet is on the CD-ROM.	**2265**
22/66	Use of ambient growth factors and balancing of attractions to productions.	The KCDOT will continue to use an ambient growth factor of 0.7% for a six year time period to account for increases in traffic that are not accounted for by land use growth. The balancing of productions and attractions will not bias the trip distribution pattern since population and employment are already nearly balanced in the model data. KCDOT uses the PSRC procedure to achieve balance.	
22/67	Trip distribution in the previous model was biased due to the use of current growth data in unincorporated King County and the lack of comparable data for cities.	The use of actual 1995 data in R95 for both cities and the county has eliminated the problem of trip distribution bias in the base year model.	
22/68	The skewed distribution caused by using inconsistent growth figures for cities and county constitutes technical error.	The technical error has been eliminated by using actual 1995 data for both cities and county. Expected growth in both cities and the county is represented by cumulative permits (cities) and cumulative concurrency certificates (county).	
23/69	Department's comparison of actual and predicted screen line volumes.	The R95 base year model is validated by the analysis of its actual and predicted screenline traffic volumes. The attachment shows the locations and designations of the analyzed screenlines. The overall result is that R95 models 98.6% of the counted traffic volumes at the 23 screenlines. Individual screenline results are attached.	**2369**
23/70	Screen line data is compromised in previous work.	The R95 screenline analysis is based on actual 1995 traffic counts (59 %) and on other available counts factored to 1995 (41%). All available count data was collected from county, city, and state sources. Where factors were used, they are the annual growth factors calculated by KCDOT Traffic Section for different parts of the county.	
23/71	Previous screenline traffic counts in many cases were not taken in the years of the screenline analysis.	See above comments regarding year of screenline counts.	
24/7[illegible]	Actual traffic counts from the year being analyzed should be used for screenlines.	Actual 1995 traffic counts at screenline locations have been used for 59% of the data.	

24/73	Screenline results on the Plateau are not consistent and actual yearly counts were not used.	The Plateau screenlines and their calibration rates are NS-5 (1.09), NS-6 (1.00), NS-8 (0.90), EW-2 (1.03), EW-4 (1.15), EW-5 (0.83), and EW-6 (0.90). They calibrate within 2% of traffic counts in total and represent good model performance on the Plateau.	2369
24/74	The screenline and individual link traffic count data is inconsistent and questionable.	KCDOT has compared about 800 road segment traffic counts with the R95 model output. The comparison is shown on a scatter diagram in the attachment. The correlation between modeled and actual volumes is 0.90 The national standard for this statistic is 0.88, as cited in national standards (attached).	2474 1744
24/75	There should be a north-south screenline between Lake Washington and Lake Sammamish to show modeling results in the major east-west corridors.	Screenline NS-9 is such a screenline and shows a calibration result of 1.08.	2369
25/76	The critical link volumes do not need to be adjusted after every model iteration.	KCDOT has calculated the critical link adjustment factors after the final iteration. The adjustment factors are shown in the attachment. Also provided here is documentation which validates the KCDOT method. See paper by Michael Birdsall.	2576
25/77	KCDOT used its old VDF values in the assignment process in its original modeling.	The R95 model uses the new VDF values in all cases..	
25/78	KCDOT did not perform sufficient model iterations.	The R95 model uses the number of iterations needed to reach equilibrium, as represented by a ½ % gap between actual and optimum..	
27/86 to 29/91	Critical links issues.	These will be discussed in the description of the concurrency determinations for specific projects.	

CONCLUSIONS

The KCDOT has exerted considerable time and effort to upgrade its base year traffic model designated R95, in response to the Hearing Examiner's criticisms of an earlier version. New land use figures have been collected for 1995, the road network has been reviewed and edited to correct errors, extensive additional 1995 traffic counts have been assembled, and new screenlines have been identified and analyzed.

The result of this work is a base year traffic model that is calibrated and reliable within PSRC standards, and that will produce acceptable concurrency test results. If additional descriptive information is needed for model assessment, please call Dick Etherington at (206) 689-4709.

The details of using R95 to determine the concurrency of a particular project will be described in materials provided with the KCDOT evidence pertaining to that project.

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APPENDIX 2

EXECUTIVE RESPONSE

King County Executive
RON SIMS

RECEIVED
MAR 2 6 1999
KING COUNTY AUDITOR

March 26, 1999

TO: Don Eklund, King County Auditor

FM: Ron Sims, King County Executive

RE: Preliminary Draft: Traffic Volume Forecast Model Special Study

Thank you for the opportunity to review the draft Traffic Volume Forecast Model Special Study. My staff in the Department of Transportation (DOT) have reviewed the report and discussed their findings and recommendations with me. They generally concur with the largely favorable findings and conclusions of this report. In addition, implementation of most recommendations is underway, and, in most cases, was in process before the audit was commenced.

Although, for the most part, this report presents an accurate description of our processes and controls, I strongly disagree with the opinion stated in Finding 1 that internal controls are weak. I believe this opinion was valid in reference to the early months of the program, but it is no longer valid. Internally, a more extensive review process was established in early 1996 as an extra quality control element of the Transportation Concurrency Program. The example cited in the report—Blakely Ridge and Northridge—occurred in the first three months of the program, before the internal Review Team had been established. Transportation Planning staff realized the need for increased internal controls and implemented the Review Team in the second quarter of 1996.

I agree that formal documentation of our procedures would improve the process, and I will include the development of procedures documentation in the work plans that will be established over the next year. As a part of the procedures, a checklist will be developed to track each step of the quality control process. As with all aspects of all our programs, staff will continue to review processes and design and implement additional controls and improved procedures wherever they may improve efficiency and accountability.

The following responses address the three recommendations associated with Finding 1.

- Recommendation 1-1: This recommendation is being implemented and will be complete by September 1, 1999.

- Recommendation 1-2: Information regarding the concurrency test failure is routinely sent to the developer. All files are open for public inspection. A summary sheet that includes the Transportation Adequacy Measure (TAM) standard and TAM score will be added as an enclosure to the concurrency certificate.

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- Recommendation 1-3: Sensitivity analysis is a separate process from the calibration and validation process. The Puget Sound Regional Council (PSRC) currently performs sensitivity analysis on the "parent" model of King County's model. This is the appropriate application of sensitivity analysis. DOT staff will participate as members of the technical team with PSRC staff as they perform sensitivity testing on the regional model.

My staff and I concur with the conclusion stated in Finding 2 that the EMME/2 travel model is an appropriate tool and is recognized as such by Washington State and local governments, academic institutions, and private consulting agencies—both nationally and internationally.

I concur with the conclusion stated in Finding 3 that relevant and appropriate improvements suggested by the 1996 Blackbox study have been or will be incorporated into the County modeling process. I also concur with the associated recommendation to continue to update the quality and integrity of the data used in the model. This recommendation is standard practice in DOT, where staff are in the process of a major model update with the technical involvement and advice from PSRC.

I concur with the conclusion in Finding 4 that DOT staff are highly qualified and competent. I am personally very proud of the technical staff we have developed over the years and the strides the County has taken to become a leader in regional, technical activities.

I concur with the conclusion in Finding 5 and have implemented internal controls to ensure data integrity. Staff will continue to review processes in an effort to identify and implement further controls. DOT staff acknowledge the importance of modeling activities in the development of the Transportation Needs Report, Mitigation Payment System, Transportation Concurrency, and Capital Improvement Program development. If you have specific questions about this finding—or any of the above findings or recommendations—please contact Roy Francis, Manager of the Transportation Planning Division, at (206) 684-1644.

Thank you for your professionalism and cooperation in working with my staff and for the quality of your report. If you have questions or comments, please do not hesitate to contact me.

RS:aa

cc: Paul Tanaka, Deputy County Executive
Dave Lawson, Manager, Executive Audit Services
Paul A. Toliver, Director, Department of Transportation, (DOT)
Roy Francis, Manager, Transportation Planning Division, DOT
Bill Hoffman, Manager, Comprehensive Long Range Planning Section, Transportation Planning Division, DOT
Sue Osterhoudt, Supervising Transportation Planner, Comprehensive Long Range Planning Section, Transportation Planning Division, DOT